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The contribution of ascitic fluid to body weight in patients with liver cirrhosis, and its estimation using girth: a cross-sectional observational study

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1 **The contribution of ascitic fluid to body weight in patients with liver cirrhosis, and its estimation**
2 **using girth: a cross-sectional observational study**

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13 **Authorship**

14 EL conceived and designed the study, collected the data, carried out the analysis and wrote the
15 manuscript. MH co-designed and acted as Chief Investigator for the study. Both authors interpreted the
16 findings, commented critically on draft versions and approved the final version of the submitted paper.

17
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22 NIHR or the Department of Health and Social Care.

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25 Dietetic and the Research, Development and Innovation Departments at the Royal Cornwall Hospital for
26 supporting this research study.

27 **Transparency Declaration**

28 The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study
29 being reported. The reporting of this work is compliant with STROBE guidelines. The lead author
30 affirms that no important aspects of the study have been omitted and that any discrepancies from the
31 study as planned (IRAS Project ID: 218747) have been explained.

32 **Conflict of Interest Statement**

33 The authors have no conflicts of interest to declare.

34 **Keywords:** ascites, weight, girth, cirrhosis, liver, Body Mass Index, Alcoholic Liver Disease.

Abstract

Background: There is a high prevalence of malnutrition among people with decompensated liver disease. Standard nutritional screening tools use weight and body mass index (BMI) to identify risk, but these are difficult to measure for those with ascites, often secondary to liver cirrhosis. Dietetic guidance suggests adjusting for ascitic weight by 2.2-14kg but there is a lack of evidence to substantiate these figures.

Aims: Measure the contribution of ascitic fluid weight and compare to the current guidance and examine whether girth circumference can be used to estimate ascitic weight.

Methods: A cross-sectional, observational study was conducted over 13-weeks. Participants attending for paracentesis were weighed, their girths measured, and BMI calculated pre-and post-paracentesis. Fluid removed via paracentesis was recorded. Ethical approval was received (IRAS ID: 218747).

Results: Eighteen participants underwent paracentesis. The range of ascitic fluid drained was 3.8–19litres (mean=8.7, standard deviation (SD)=3.7). Weight difference range between pre-and post-paracentesis=4.5–20kg, (8.7, SD=3.9). Ascitic fluid weight is shown to be higher in each category (minimal, moderate, severe ascites) than the current guidance figures. Weight difference was greater than 14kg in 11% ($n=2$) of participants. A strong, statistically significant relationship ($\rho=0.68$, $p<0.01$) between ascitic weight and pre-paracentesis girth was found. An equation was formulated to enable the estimation of ascitic fluid from pre-paracentesis girth.

Conclusion: Current dietetic guidance should be re-evaluated to reflect the greater weight differences identified. Measuring girth pre-paracentesis may help to inform dry weight estimation. Further research is required to verify the accuracy of estimating ascitic weight from pre-paracentesis girth.

Introduction

It is widely recognised that people with liver disease are at high risk of protein-energy malnutrition (PEM)^(1; 2; 3). Evidence shows a particularly high prevalence of PEM amongst those with decompensated cirrhosis, reportedly between 50 and 90 percent^(4; 5). The reasons for this are multifactorial and include metabolic changes secondary to cirrhosis; poor nutritional intake consequential to nausea, early satiety, dysgeusia (taste changes) and dietary restrictions; additionally, malabsorption due to bile-acid deficiency or small-bowel bacterial overgrowth⁽⁶⁾. Malnutrition in liver disease is associated with a poor quality of life⁽⁷⁾, increased duration of hospital stay, higher rates of mortality and morbidity, sarcopenia, increased infection risk and increased risk of encephalopathy^(5; 8). Given the gravity of these associated complications it is imperative that malnutrition is identified to enable the provision of appropriate specialised nutrition support which can help improve or reduce complications⁽⁹⁾.

70 Assessing the nutritional status of patients is commonly undertaken using a nutritional screening tool.
71 Standard screening tools in the United Kingdom include the ‘Malnutrition Universal Screening Tool’
72 (MUST)⁽¹⁰⁾ and the ‘Subjective Global Assessment’ (SGA)^(11; 12). These screening tools use weight and
73 BMI as primary components, however as these components are affected by fluid weight, including
74 ascites (a common symptom of decompensated liver disease), their use for patients with excess fluid is
75 limited. There is currently no agreed gold-standard method of malnutrition screening for patients with
76 liver disease⁽¹²⁾, consequently their malnutrition risk is often under-recognised⁽⁵⁾. The American
77 Society for Parenteral and Enteral Nutrition (ASPEN) guidelines for the care of this patient group⁽¹¹⁾,
78 recognise this and as such, provide a greater emphasis on the benefits of a full nutritional assessment. It
79 is recommended that this is carried out by a dietitian⁽¹³⁾ and is a more in-depth and specialised process
80 than nutritional screening.

81 Obtaining a dry weight (i.e. actual body weight without ascitic fluid or oedema) or estimating the weight
82 of ascitic fluid is required to assess patients however, this can be difficult to obtain or estimate. An
83 actual weight after paracentesis is not always measured, particularly on hospital wards. Therefore, when
84 carrying out a full nutritional assessment, and to guide the estimation of dry body weight, UK based
85 dietitians may refer to the Pocket Guide for Clinical Nutrition, Parenteral and Enteral Nutrition Group
86 (PENG)⁽¹⁴⁾. This provides reference guidance to adjust for weight of ascites by 2.2kg for minimal
87 ascites to 14kg for severe ascites. It is acknowledged this often underestimates ascitic weight^(14; 15). The
88 evidence underpinning these figures stems from the American Veteran Administration Studies carried
89 out in the 1980’s⁽¹⁶⁾, which looked at weight gain among veterans with alcoholic liver disease in receipt
90 of nutritional therapy.

91 By employing the practical method of measuring weight before and after paracentesis (the draining of
92 ascitic fluid via a tube inserted into the abdomen) the present study provides evidence to help inform the
93 estimation of ascitic weight. Additionally, girth (abdominal circumference) measurement as a way of
94 estimating ascitic weight has, to the authors’ knowledge, only been explored via a single case study⁽¹⁷⁾
95 whose findings suggest that one inch equates to one kilogram of ascitic fluid. However, as well as the
96 clear limitations of a case study, the worth of this formula requires pre-existing knowledge of girth
97 measurement and therefore offers no practical method of estimating ascitic weight from pre-paracentesis
98 girth. The present research study, therefore, provides novel findings that can be applied in practice.

99 Patients who had undergone paracentesis were consulted about the importance of investigating these
100 issues and all patients felt the study was both important and acceptable.

101 Ultimately, overestimation of BMI can lead to malnutrition risk being overlooked. Likewise,
102 overestimating weight can result in a compromised nutritional assessment, as well as having

103 implications for prescribing medications. A more accurate method of estimating dry weight of patients
104 with ascites would reduce the risk of compromised nutritional screening and improve the accuracy of
105 dietetic assessment.

106 In this study, we test the following hypotheses: ascitic fluid volumes can contribute greater weight gains
107 than current guidance suggests, and that abdominal girth circumference can be used to estimate ascitic
108 weight. Together these will improve the accuracy of dry weight estimation for patients with ascites,
109 secondary to liver disease, and consequently the accuracy of nutrition assessment and screening.

110

111 **Methods**

112 This study received approval from the Health Research Authority (IRAS project ID: 218747, REC
113 17/EE/023). Participants were eligible for inclusion if they were patients attending the Medical Day
114 Unit (MDU) at the general district hospital for the region, for therapeutic paracentesis drainage with
115 tense ascites secondary to liver disease. Prospective participants were identified from a clinic list of
116 patients who were booked in for therapeutic paracentesis. It was expected that they would primarily
117 have ascites secondary to liver disease, but this was confirmed prior to inclusion. Letters of invitation,
118 including study information and consent form, were sent with their standard paracentesis appointment
119 letters, so patients could take part at their next clinical appointment. It was anticipated that patients may
120 attend the MDU multiple times over the study duration; they were eligible to participate at each
121 attendance, but repeat participation was noted. Patients were excluded if they were unwilling or unable
122 to remove thick clothing, unable to stand unaided, or were unable or unwilling to give written informed
123 consent.

124 **Data collection**

125 All data were collected by EL eliminating inter-observer variability⁽¹⁸⁾ and standard assessment
126 protocols were followed to limit intra-observer variability. Demographic data were obtained from the
127 participant (gender, ethnic origin, age, the aetiology of the liver disease and duration since diagnosis).
128 Presence of peripheral oedema was based on patient reporting, clinical judgement, observation and the
129 guidance provided by PENG⁽¹⁴⁾, where minimal, moderate and severe oedema are given estimated
130 values of 1kg, 5kg and 10kg respectively. Weight, height and girth were then measured according to
131 WHO protocols⁽¹⁹⁾, described briefly as follows:

132 *Weight:* Participants were asked to stand on calibrated scales placed on a flat, firm surface, after first
133 removing all heavy or outer clothing, including footwear and headwear. Weight was noted to one
134 decimal place in kilograms (kg).

135 *Height:* Participant removed heavy or outer clothing, including footwear and headwear, with their hair
136 flattened down to the scalp. The participant stood with their feet together, legs straight and heels against
137 the backboard of the stadiometer. With the participant's head in the Frankfort plane ⁽²⁰⁾, the measure
138 lever was positioned, compressing hair as required. Height was read to nearest 0.1cm.

139 *Abdominal girth:* Using a disposable non-stretch paper tape measure, measurement was taken as close to
140 skin as possible or over light clothing; only heavy clothing was removed. The participant stood upright,
141 with feet together and arms resting at the sides. The participant located the midpoint between the top of
142 the hipbone and last palpable rib, and then wrapped the measuring tape around their girth at this point.
143 The researcher ensured the tape was parallel to the floor, horizontal across the back and front of the
144 body, and around the widest part of the girth. The measurement was taken to the nearest 0.1cm, at the
145 end of expiration, with the tape as close to skin as possible without compression.

146 Data were collected between March and June 2017.

147 **Statistical analysis**

148 A formal sample size calculation was not used. The aim was to recruit as many people as possible in the
149 four months available for data collection. On average seven patients attend the unit each week, thus we
150 estimated there would be approximately 112 patient visits that might be eligible for inclusion during
151 the study period. .

152 Analysis was carried out using Statistical Package for Social Sciences (SPSS) Version 23 (IBM, 2015).
153 Spearman correlation coefficients (*rho*) were conducted for continuous and ordinal, non-parametric
154 variables, along with Pearson's rank correlation coefficients (*r*) for parametric variables. For all analyses
155 $p < 0.05$ was considered statistically significant.

156 To test the second hypothesis, that pre-paracentesis abdominal girth circumference can be used to
157 estimate ascitic weight, an initial descriptive analysis was undertaken. This was followed by the
158 exploration of relationships between girth, fluid drained and difference between pre-and post-
159 paracentesis weight using scatterplots. Correlation coefficients were then explored using all participant
160 visits to increase the strength of statistical tests. The strength of the correlation coefficients was
161 regarded as strong where $r = 0.50$ to 1.00 , moderate where $r = 0.30$ to 0.49 , and weak where $r = 0.10$ to
162 0.29 ⁽²¹⁾.

163 To calculate the coefficient of determination, which offers an idea of how much variance the variables
164 share, the r values were squared and converted into a percentage of variance. Linear regression was
165 performed to assess the relationship between pre-paracentesis girth and body weight difference to
166 discover a regression equation. R-squared is a statistical measure of how close to the regression line the

167 data fit ⁽²²⁾. To measure the level of agreement between the estimated ascitic weight from girth
168 circumference and the actual measured ascitic weight, a Bland-Altman plot was used ⁽²³⁾. To estimate
169 statistical power a post hoc analysis was undertaken using the statistical package Minitab (State College,
170 PA: Minitab, Inc).

171

172 **Results**

173 Figure 1 displays study participation details, including reasons for exclusion. This shows that over the
174 13-week data collection period 47 study assessments were made, including 24 unique individuals, of
175 whom 18 underwent full paracentesis at least once. There was a total of 38 paracenteses drains for
176 which all the required data were collected. Three patients declined to have post-paracentesis data
177 measured and six were not drained due to inadequate fluid.

178 Table 1 summarises the demographic characteristics of the 24 unique participants who consented to
179 taking part in the study and the 18 participants who had paracentesis. All consenting participants had
180 baseline data collected (including demographic information, pre-paracentesis weight, girth and height)
181 and all of these potential participants are included in figure 1 and table 1 for completeness. All were of
182 white British ethnic origin, they had a mean age of 65 years, the majority were male, diagnosed with
183 alcoholic liver disease of over 2 years duration, had two or more previous paracentesis, used diuretics,
184 and had minimal or no peripheral oedema.

185 Our first hypothesis was that ascitic fluid volumes can contribute greater weight gains than current
186 guidance suggests. Using only data from each unique participant's first paracentesis (first time of study
187 participation) (n=18), table 2 shows the range of volume of fluid drained and pre-and post-paracentesis
188 weight difference, compared to the current guideline weights ⁽²⁴⁾. The values from our sample were
189 divided into tertiles to allow estimates for minimal, moderate and severe ascites in accordance with the
190 guideline ⁽²³⁾. The current guideline appears to under-estimate weight contribution of ascitic fluid for
191 many patients. Figure 2 displays the weight difference and fluid volume drained for each of the
192 individual participants, indicating that two (11%) patients had ascites greater than 14kg. One
193 participant's weight difference was 6kg over the maximum in the guidelines.

194 The changes in BMI pre-and post-paracentesis are shown in figure 3, which also depicts where there
195 was a change in the classification category of BMI. Table 3 shows BMI split into its quartile categories
196 with the number and percentages of participants falling within each category both before and after
197 paracentesis. This table and figure show that all participants' BMI reduced post-paracentesis, with 56%
198 (n=10) of participants' BMI falling into a lower category post-paracentesis and 61% (n=11) falling into
199 a lower category when weight was additionally adjusted for oedema.

200 Our second hypothesis was that abdominal girth circumference can be used to estimate ascitic weight.
201 For these analyses we used data from the 38 paracentesis drains for which we had complete data.
202 Testing showed that the difference in girth pre and post paracentesis was positively skewed with a non-
203 normal distribution; consequently, non-parametric tests were employed. Median (9.6cm) and inter-
204 quartile range (IQR: 8.0-12.0cm) were calculated along with the minimum (2.5cm) and maximum
205 (18.7cm). Strong and statistically significant correlations were found between fluid drained and weight
206 difference ($\rho=0.88$, $p<0.01$), fluid drained and girth difference ($\rho=0.67$, $p<0.01$), and weight
207 difference and girth difference ($\rho=0.60$, $p<0.01$). Unless dry girth (i.e. post paracentesis) is known
208 these relationships are not clinically useful, nevertheless, it suggests that a relationship exists. In our
209 sample we asked participants to estimate their dry girth but only 38% attempted to do so (18/47), and of
210 these none were within 10% of their measured post-paracentesis girth. Since pre-paracentesis girth can
211 be measured, its relationship with pre-and post-paracentesis weight difference would be clinically
212 useful, since potentially it could be used to predict weight difference. The Spearman's correlation
213 coefficient demonstrated a strong and significant relationship ($\rho=0.68$, $p<0.01$) with a regression
214 equation:

215 Weight difference (kg) = $-20.05 + 0.25 * x$ (where x = pre-paracentesis girth in cm).

216 A Bland-Altman plot is presented in figure 4. This illustrates the level of agreement between predicted
217 and measured ascitic fluid weights, with 92% ($n = 35/38$) of results lying within the 95% limits of
218 agreement. The line of best fit slopes upward ($R^2=0.277$) indicating that the equation tends to
219 overestimate at small weight differences and underestimate at larger weight differences. An ideal line of
220 best fit would be horizontal.

221 A post hoc estimation of statistical power was carried out using the statistical package Minitab (State
222 College, PA: Minitab, Inc) to check the probability of a type 2 error. Using the difference in means of
223 3.16 kg and 3.16 litres in pre-and post-paracentesis weight and fluid volume, a $SD=3.9$, $\alpha=0.05$, and
224 a sample size of 18 unique participants the power was 0.9 or 90%, suggesting a low probability of a type
225 2 error (accepting the null hypothesis when it is actually false).

226 **Discussion**

227 In order to correctly identify people at risk of undernutrition and thus initiate treatment plans, it is
228 crucial to measure dry weight in patients retaining fluid. However, this is often not practicable and so
229 the accurate estimation of the contribution ascitic weight makes to total body weight is important. This
230 study shows that ascitic fluid volumes can contribute greater weight gains than current guidance
231 suggests, supporting the first hypothesis. Ascitic fluid weight is shown to be higher in each category

232 (minimal, moderate, severe ascites) than the figures in current guidance ⁽²⁴⁾, with 11% of participants
233 over the maximum value of 14kg. However, it is important to note that this study provides results
234 generalisable only to those with tense ascites that is large enough to warrant paracentesis. The data
235 supporting the current guidelines originates from studies carried out by Mendenhall in the 1980's, for
236 the Veterans Health Administration Cooperative Studies Program ⁽¹⁶⁾. The study sample used by
237 Mendenhall were military and based ascitic fluid weight on approximations developed from calculations
238 using dry body weight and weight gain among American military veterans with alcoholic liver disease
239 who were receiving nutritional therapy. This study sample is not representative of a British civilian
240 population and thus has considerable limitations.

241 The importance of dry weight estimation is demonstrated by the change in BMI pre-and post-
242 paracentesis. BMI calculated using pre-paracentesis weight over-estimated BMI, resulting in patients
243 being classed in higher BMI categories. When post-paracentesis weight was used 56% of participants
244 dropped into a lower BMI category, moving two people from normal weight to underweight.
245 Nevertheless, despite patients with liver disease being at risk of undernutrition, the majority of
246 participants did not have a dry BMI that fell into the underweight category. This could be partly
247 explained by fluid retention despite paracentesis but could also suggest that our study sample had a
248 lower proportion of underweight individuals than expected. Ten of the eighteen participants had
249 additional fluid retention in the form of peripheral oedema, which is not affected by paracentesis.
250 Although we accounted for this oedema using practice guidelines ⁽¹⁴⁾, clinical judgement and patient
251 reporting, it was not an objective measurement, therefore the accuracy of dry weight estimation is still
252 uncertain. The evidence for the oedema data in the current practice guidelines is unknown ⁽²⁰⁾. In
253 addition, despite therapeutic paracentesis draining off as much ascitic fluid as possible, there may still
254 have been some remaining thereby confounding the final dry weight. There was no way of alleviating
255 this risk, however given the duration of paracentesis and the fact that the drains had slowed to dry prior
256 to removal, the volumes of fluid remaining post-paracentesis were likely to have been minimal.

257 Paradoxically, evidence suggests that being overweight or obese may have a protective effect for those
258 with cirrhosis, with lower mortality rates in hospitalised cirrhotic patients with obesity ⁽²⁵⁾. This is
259 thought to be due to the greater nutritional reserves associated with obesity which play a part in
260 increasing survival rates during acute illness ⁽²⁵⁾. Thus, it may be that BMI categories for the general
261 population are not appropriate for those with cirrhosis and adjusted categories should be developed.

262 It is well accepted that BMI alone is not suitable for assessing malnutrition risk ^(9; 10; 26), and some
263 screening tools do not require it at all ⁽²⁷⁾. Many screening tools include an assessment of unintentional
264 weight loss but estimating unintentional weight loss in patients with ascites requires a succession of dry
265 weight measurements. This would be easier in routine practice if more accurate estimations of ascitic

weight were available, as we present here. Clearly, the most accurate method would be to weigh patients' post-paracentesis, adjusting for any other oedema, but this is not always possible.

A relationship between pre-paracentesis girth and ascitic weight was found and this has the potential to aid ascitic weight estimation and consequently dry weight calculation, in particular for those unable to undergo paracentesis or when nutritional assessment is required when a dry weight is not available. However, the equation we developed did not provide a precise enough estimate; only 34% of participants' weight difference could be predicted to within 1kg. 84% of participants' weight could be predicted to within 3kg but this is not accurate enough for reliable nutritional screening. Further research is recommended to verify the accuracy of variance and clinical sensitivity of these important and novel findings.

One weakness of this study is the lack of ethnic diversity in the study population; the sample were only of White British origin. This is reflective of the local population ⁽²⁸⁾ but limits the applicability of the data to patients from other ethnic backgrounds. Additionally, the data were not analysed according to gender (due to the small sample size), therefore it was not possible to identify any specific gender differences. Another limitation is that the influence of food and fluid intake, IV albumin solution or bowel movements on weight were not accounted for; diurnal variation in weight may be as much as 2kg ⁽²⁰⁾. These factors may account for the differences found between weight and fluid volume drained. Finally, our study is small with only 18 unique participants; a larger sample to confirm our formula would be beneficial.

In summary, this study shows that the current guidelines for the weight of ascitic fluid may underestimate the true value in this sample of patients with cirrhosis of the liver. However, because patients with minimal ascites may not have adequate ascitic volume to drain, ascitic weight may be overestimated in this group. We recommend that the guidelines are updated using these contemporary and robustly derived figures. However, they should be used with caution in ethnic groups other than white British. It may be possible to estimate ascitic fluid weight using the pre-paracentesis girth measurement, but the formula requires further validation.

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299 **Acknowledgements**

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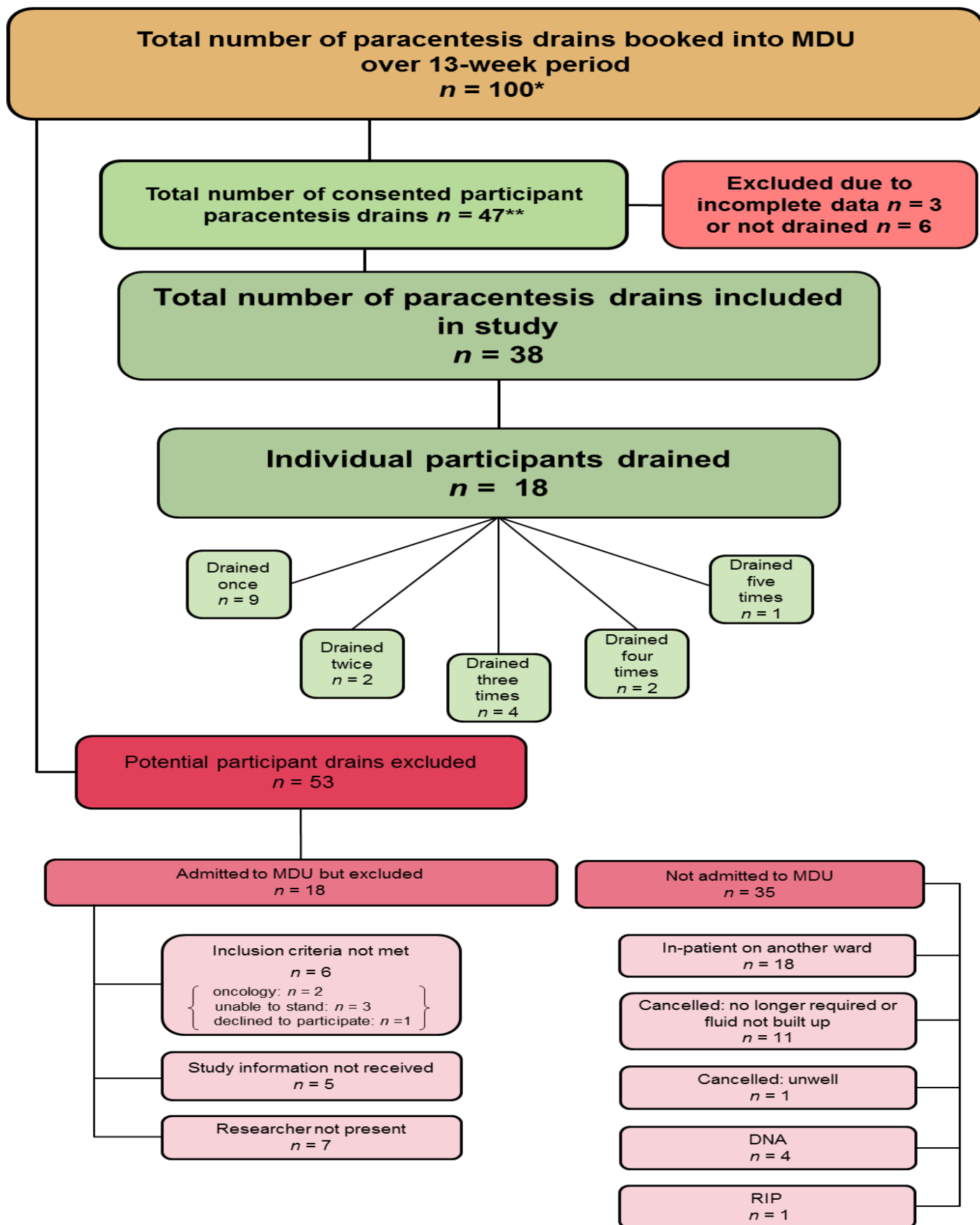
310 **Conflict of Interest Statement**

311 The authors have no conflicts of interest to declare.

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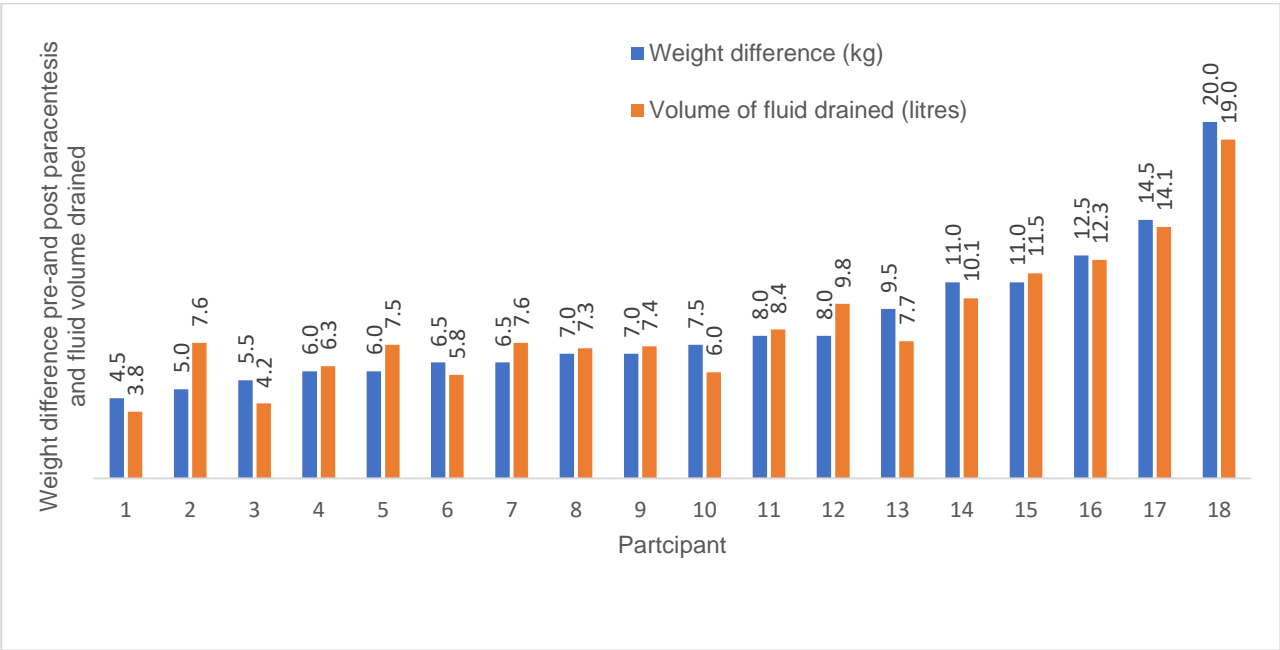


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377

378 *Figure 2. Weight difference pre- and post-paracentesis and the volume drained for each of the 18 unique*
379 *participants.*

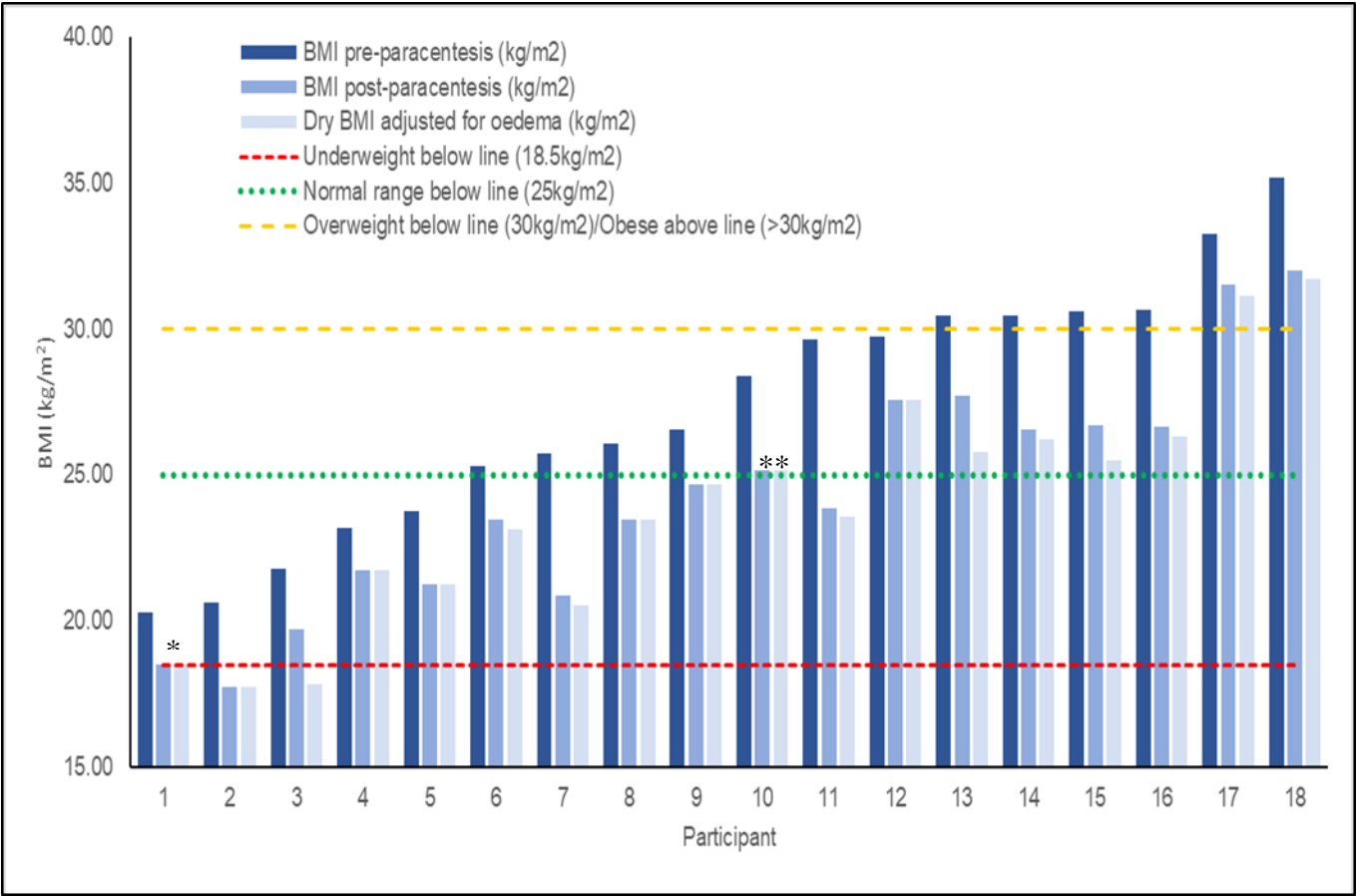
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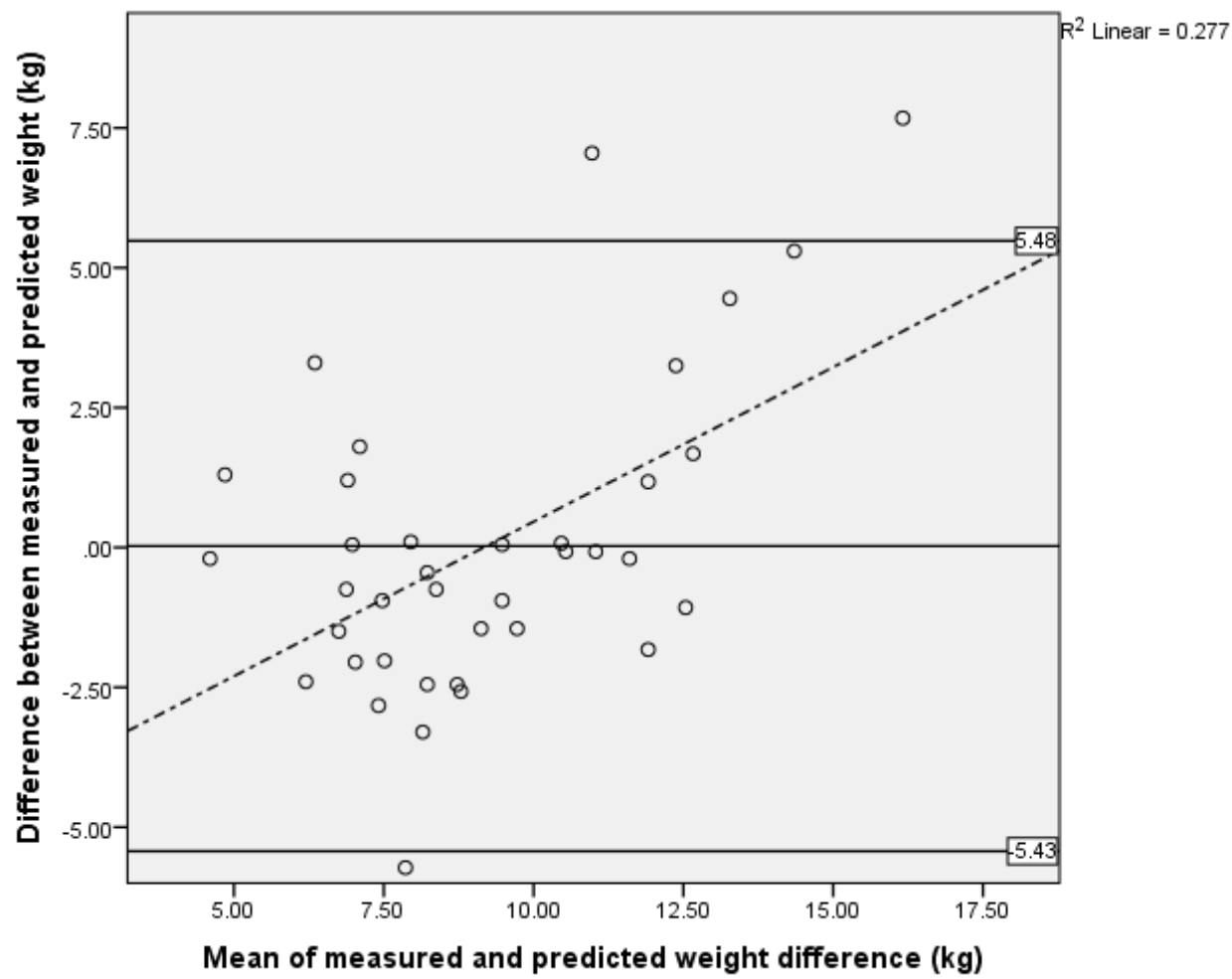
383 *Figure 31. Body Mass Index pre- and post-paracentesis and additionally adjusted for peripheral*
 384 *oedema for each of the 18 unique participants, and comparison with Body Mass Index categories.*



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 386 **Participant 1, post-paracentesis BMI=18.5kg/m², ** Participant 10, post-paracentesis BMI=25.2kg/m²*
 387 *NB: Oedema estimated based on a combination of clinical judgement, participant reported volume and guidance*
 388 *according to Todorovic and Micklewright (2011) ⁽¹⁴⁾*

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396 *Figure 4. Bland-Altman plot of difference between measured ascitic weight and predicted weight from*
397 *pre-paracentesis girth, using above equation*

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400 Table 1. Unique participant demographics

		All participants recruited (n=24)		Participants with at least one completed paracentesis (n=18)	
		Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Gender	Male	17	70.8	14	77.8
	Female	7	29.2	4	22.2
Ethnicity	White British	24	100	18	100
	Other	0	0	0	0
Aetiology of liver disease	Alcoholic liver disease	16	66.7	11	61.1
	NAFL	2	8.3	2	11.1
	Hepatitis C	2	8.3	2	11.1
	Cryptogenic	4	16.7	3	16.7
Previous number of paracentesis	None	3	12.5	0	0
	One	6	25.0	5	27.8
	Two or more	15	62.5	13	72.2
Diuretic use	No	5	20.8	4	22.2
	Yes	19	79.2	14	77.8
Estimated amount of peripheral oedema* (kg)	None (0)	14	58.3	8	44.4
	Minimal to moderate (0.5-<5)	8	33.4	8	44.4
	Moderate to severe (5-10)	2	8.4	2	11.1
Duration since liver disease diagnosis	Less than 6 months	7	29.2	3	16.7
	6 months to 1 year	2	8.3	1	5.6
	1-2 years	4	16.7	4	22.2
	Over 2 years	11	45.8	10	55.6
Participant age (years)		Range = 45-83 Mean (SD) = 65 (10.5)		Range =45-83 Mean (SD) = 65 (10.6)	

401 * Oedema estimated based on a combination of clinical judgement, participant reported volume and guidance
402 according to Todorovic and Micklewright (2011) ⁽¹⁴⁾.SD=Standard deviation; NAFL=non-alcoholic fatty liver

405 Table 2. The range of pre-and post-paracentesis weight difference and volume of fluid drained in the
 406 study sample compared to current dietetic guidelines.

Current dietetic guidelines*		Findings from present study		
Guide for assessing weight of ascites (kg)	Ascitic weight difference (kg) <i>n</i> = 18	Ascitic volume drained (litres) <i>n</i> = 18 (SD)	Ascitic weight difference (kg): Range in tertiles (mean of tertile)	Ascitic fluid drained (litres): Range in tertiles (mean of tertile)
Minimal 2.2	Minimum 4.5	Minimum 3.75	4.5 – 6.5 (5.6)	3.75 - 7.3 (5.6)
Moderate 6	Mean 9.2 (SD:3.5)	Mean 9.1 (SD:3.5)	6.5 – 8 (7.3)	7.4 - 8.35 (7.7)
Severe 14	Maximum 20	Maximum 19	9.5 – 20 (13.1)	9.8 – 19 (12.8)

407 *Wicks and Madden (1994) ⁽²³⁾.
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410 Table 3. Body Mass Index pre- and post-paracentesis, adjusted for peripheral oedema for the study
 411 sample, and comparison with Body Mass Index categories.

Classification Category	BMI (kg/m ²)	Percentage in category pre- paracentesis (n)	Percentage in category post- paracentesis (n)	Percentage in category post-paracentesis adjusted for peripheral oedema (dry BMI) (n)
Underweight	<18.5	0% (n=0)	6% (n=1)	11% (n=2)
Normal weight	≥ 18.5 – 24.9	28% (n=5)	55% (n=9)	44% (n=8)
Overweight	≥ 25.0 – 29.9	39% (n=7)	33% (n=6)	33% (n=6)
Obese	≥ 30.0	33% (n=6)	11% (n=2)	6% (n=2)

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413 Oedema estimated based on a combination of clinical judgement, participant reported volume and guidance
 414 according to Todorovic and Micklewright (2011) ⁽¹⁴⁾

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